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X-ray Thomson Scattering from Dense Plasmas

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Tutorial talk nomination for the
49th Annual Meeting of the Division of Plasma Physics, November 12-16, 2007 , Rosen
Centre Hotel , Orlando, Florida

X-ray Thomson scattering in dense plasmas*

O. L. Landen

Lawrence Livermore National Laboratory, USA

Advances in the development of laser-produced x-ray sources have enabled a new class of high-energy density physics experiments. Powerful narrow-bandwidth x rays penetrate through short-lived hot dense states of matter and probe the physical properties with spectrally resolved x-ray scattering. Experiments from isochorically-heated plasmas with electron densities in the range of solid density and above have been demonstrated allowing for the first time exploration of the microscopic properties of dense matter regime close to strongly-coupled and Fermi degenerate conditions. Backscatter measurements have accessed the non-collective Compton scattering regime, which provides accurate diagnostic information on the temperature, density and ionization states. The forward scattering spectrum has been shown to measure the collective plasmon oscillations. Besides extracting the standard plasma parameters, density and temperature, forward scattering yields new observables such as a direct measure of collisions, quantum effects and detailed balance. In this talk, we will discuss new results important for applications of this technique for novel experiments in a wide range of research areas such as inertial confinement fusion, radiation-hydrodynamics, material science, and laboratory astrophysics.

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Supporting remarks:

Dr. Landen is the Associate Program Leader for Target Physics in the National Ignition Facility Program at the Lawrence Livermore National Laboratory. Dr Landen is a fellow of the American Physical Society and has led numerous laser experiments on the development and applications of x-ray sources. Dr. Landen first proposed x-ray Thomson scattering for probing Warm Dense Matter and has overseen the implementation of this novel experimental method at the Omega Laser Facility as senior scientist.

In this tutorial talk, Dr. Landen will present the extension of scattering theory and experimental techniques from traditional optical Thomson Scattering to the x-ray regime, including providing a historical perspective from the early days of Compton scattering off room temperature solids. He will relate the experimental observables to dynamic structure factor calculations and discuss the results in terms of various physics models.

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He will further provide an outlook discussing future applications, e.g., for probing extremely dense states of matter in future experiments on the National Ignition Facility.

Publications

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